

## INDUSTRY DEVELOPMENT

### Full Paper

## **ENVIRONMENTAL SUSTAINABILITY – A DRIVER FOR INNOVATION IN CONSTRUCTION SMES?**

**David Thorpe**

*University of Southern Queensland, Australia*

[thorped@usq.edu.au](mailto:thorped@usq.edu.au)

**Neal Ryan**

*Southern Cross University, Australia*

[neal.ryan@scu.edu.au](mailto:neal.ryan@scu.edu.au)

**Michael B. Charles**

*Southern Cross University, Australia*

[michael.charles@scu.edu.au](mailto:michael.charles@scu.edu.au)

## ABSTRACT

While there is increased emphasis on sustainability in the construction industry, it is uncertain whether the SME sector sees it as a driver of innovation. This lack of concern could occur for several reasons, such as material cost, uncertainty regarding the potential risks associated with sustainable practices, perceived lack of business benefit, and lack of informed client demand.

To explore such issues, a sample of smaller domestic builders in South East Queensland were asked, as part of a broader study of innovation in these firms, to provide their views on environmentally sustainable building practices. While a number of these firms identified sustainability related innovations as important, responses were less clear with respect to environmental sustainability as a driver of innovation.

This paper uses this research to examine sustainability as a potential driver for innovation in the SME sector of the construction industry, and to suggest approaches to enhance such innovation.

**Keywords:** Innovation, sustainability, construction, building, residential, environment

## 1.0 INTRODUCTION

Environmental sustainability stands alongside globalisation, new materials, and new information and communication technologies (ICT), in addition to governance and regulation, as an especially important factor in the construction industry, both now and into the future. The growth of its importance is reflected, for example, not only in an increasing discussion of environmental issues in both academic and practitioner-oriented circles, but also in changing regulations and building codes (Department of Trade and Industry 2006). In addition, environmental sustainability has emerged as a potential consideration in multi-criteria contract selection processes (Adjetunji, 2003).

While the increased emphasis on sustainability in the construction industry may be recognised as one of the factors influencing its future direction, it is uncertain whether the SME sector sees it as an important driver of innovation. A lack of interest in the adoption of innovative practices could arise on account of a number of reasons, such as the relatively high cost and unavailability of many sustainable materials compared with traditional materials, uncertainty regarding lifecycle performance of such materials, uncertainty with respect to the benefit to the firm of sustainable building practices, and a lack of informed client demand, particularly in the residential building market.

In order to explore such issues, a sample of smaller domestic builders in South East Queensland were asked, as part of a broader study of innovation in these firms, to provide their views on environmentally sustainable practices. While a number of these firms identified a particular sustainability-related innovation as being important to them, responses were less clear with respect to the benefits of using sustainable practices to the industry and the firm, and the impact of sustainability initiatives on practices within the firm.

This paper, which uses this research as a basis for analysis and discussion, examines the issue of sustainability as a potential driver for innovation in the SME sector of the Australian construction industry. It also explores the potential impact of an increasingly environmentally conscious marketplace on SME business practices and operations.

## 2.0 INNOVATION IN THE CONSTRUCTION INDUSTRY

In Australia, the construction industry is recognised as a significant component of the economy. For example, in the five years to 2003, the industry contributed an average of almost 6 per cent of Australia's gross domestic product and, in 2003-03, was Australia's fourth-largest industry (Australian Bureau of Statistics, 2005a, p. 562). An important characteristic of this industry is the strong representation of small and medium enterprises (SMEs). One source, for example, noted that as many as 94 per cent of Australian construction businesses employ fewer than five people each (Hampson and Brandon, 2004, p. 10). This finding is supported by a 1996-97 survey of the private sector construction industry, which stated that the average number of employees in the Australian construction industry was, at that time, 4.1 persons (Australian Bureau of Statistics, 1998, p. 5).

The construction industry is also important from an international viewpoint. The 2004 OECD *Science Technology and Industry Outlook* reported that, across the OECD countries, construction added 6.0 per cent to gross value added in 1995, and 5.4 per cent to gross value added in 1999 (OECD, 2004, p. 226). It has also been reported that, in the European Union, the construction sector typically contributes 6 per cent to the gross domestic product of countries and employs about seven per cent of the working population (European Commission, 2004, p.1).

As a result, any contribution to productivity in the construction industry can significantly and positively impact on world economies. Despite this, reports on the Australian construction industry have indicated that, although innovation occurs, the rate of innovation for the industry is not as high as that experienced in comparable industry sectors, such as manufacturing. It was found by the Australian Bureau of Statistics, for example, that the construction industry, at 30.7 per cent, had one of the lowest proportions of innovating businesses (Australian Bureau of Statistics, 2005b, p.5). This finding is supported in the international context by European research (Koivu and Mantalya, 2000; O'Farrell and Miller, 2002). Other research reports that there is a low level of innovation in the European construction sector, and that the level of investment in research training and development in the European construction industry was generally lower than 0.5% (European Commission, 2004, p.2). While the construction industry as a whole may not tend to be especially innovative, there have been reports of considerable innovation at firm level. For example, it has been reported that a considerable numbers of ideas are generated in the industry (Winch, 1998). Studies have also reported that, where required, the industry has independently developed new approaches in order to solve project-related problems (for example, Harty, 2005).

Finally, it has been observed that factors such as globalisation of the business environment, demographic change, environmental sustainability and climate change, new materials and technologies, ICT, and governance and regulation may have a significant impact on the construction industry (Hampson and Brandon, 2004, p. 2). At the same time, there appears to be a paradigm shift affecting the construction industry, with the award of contracts moving from lowest price to multi-criteria selection processes. Incorporating sustainability in such processes has been claimed to reduce risk and improve the chances of obtaining value for money (Adjetunji et al., 2003).

One of the construction industry sectors in which the amount of innovation not only impacts on value for money, but also sustainability and occupational health and safety (OHS), in addition to other important societal values, is the domestic building construction industry. This industry, as noted above, contains a large number of SMEs. It is also not as well researched as other sectors of the construction industry, especially with respect to its degree of innovation. Therefore, as a pilot for research for innovation in this sector of the Australian construction industry, research was undertaken in South-East Queensland, Australia, into innovative practices in 20 smaller residential building construction firms. One of the key focus areas of this research was sustainable design and construction. This paper employs results from this research to discuss whether sustainability can be a driver of innovation in the SME sector of the Australian construction industry.

### **3.0 WHAT IS INNOVATION?**

The economist Schumpeter described an innovation as “new combinations”, i.e., of bringing a new product to market, introducing a new method of production, initiating a new market, opening new sources of supply, or creating a new organisation of industry (Nordfors et al., 2005). Put more simply, an innovation is “an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 2003, p. 12). A further definition is provided by the OECD (2005, p. 46), which defines innovation as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method”. Another view is that it is a process through which economic and social value is extracted from knowledge through the generation, development and implementation of ideas in order to produce new or improved products, services or processes (Business Council of British Columbia, 2006, p.1). An innovation, in its broadest sense, is thus something new (or possibly altered) in processes, products, organisation or marketing, all of which are intended to have an economic benefit. This is the

definition of innovation used in this paper. According to this description, the term “economic” has been broadened to include environmental and/or social outcomes, in addition to traditional monetary outcomes.

It is well known that innovations have a limited life cycle. Indeed, the market performance of technologies decreases with time, a relationship shown by the well-known “S” curve of an innovation’s performance over time (Lee and Nakicenovic, 1988). For this reason, innovations should be used early in their lifecycle if they are to provide maximum benefit to users. Conversely, there is potential risk in using untried innovations very early in their lifecycle.

Research has found that there are a number of drivers and barriers to innovation. Thus, a wide-ranging survey of innovation in Australian businesses found that the primary drivers of innovation were profit and market related, followed by legal related drivers, while the main barriers were cost and market related (Australian Bureau of Statistics 2005b, pp. 20, 28). A study of the Australian construction industry found that the two main drivers of innovation were the need to a) improve efficiency and productivity and b) respond to client/customer demands, while the two major obstacles were time and cost (Manley et al., 2005, p. 34, 35). Additional barriers to innovation include a) risk, uncertainty, change and knowledge (Love et al., 2001); b) organisational size (Arias-Aranda et. al., 2001; Acar et al., 2005), and c) cultural context (Acar et al., 2005).

## **4.0 SUSTAINABLE PRACTICES AND CONSTRUCTION**

A common definition of “sustainable development” is that proposed by the 1987 report of the World Commission on Environment and Development, which defines this term as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987, p. 54). This represents a significant challenge for the construction industry, the purpose of which is to consume resources through undertaking development of the earth for the benefit of human beings.

At the same time, sustainability is becoming an important focal point from a global construction perspective. For example, it has been observed that construction activities significantly impact on waste, energy use and greenhouse gas emissions. In addition, it has been reported that, in the United Kingdom, 17 per cent of wastes going to land disposal (which can potentially have an impact on the earth’s atmosphere by means of oxidation) are directly related to construction activities (Wallace, 2005, p. 82). Such impacts have clearly led to a growing emphasis on corporate sustainability. This, in turn, is reflected by pressure being exerted by clients, government and other stakeholders for the construction industry to be more accountable for its social and environmental impacts. Thus sustainability considerations are becoming more significant in the construction process, including, as stated previously, contract selection. In this context, adopting sustainable practices and processes reportedly reduces risk and increases the probability of obtaining value for money (Adjetunji et. al, 2003).

Regulatory authorities are also recognising the importance of sustainable practices in construction. The United Kingdom, in 2000, implemented a strategy for more sustainable construction that packaged the traditional components of sustainability (viz., environmental, economic and social) into a single set of objectives that aim to make the construction industry more profitable and competitive, all the while considering the requirements of stakeholders, the natural environment, and energy consumption (Department of the Environment, Transport and the Regions, 2000, pp. 8, 14-16). This strategy is ongoing, with revised targets and visions set for 2015 and beyond (Department of Trade and Industry, 2006, pp. 100-103). In similar fashion, Australia has implemented new energy-efficiency

measures for buildings (Australian Building Codes Board, 2005). This focus on sustainable construction by both building authorities and the academic literature has given it a wide-ranging meaning that includes design and operations, in addition to the actual construction process.

When considering the impact of environmental sustainability on innovation in the construction industry, it is important to understand that the generally positive view discussed above may be tempered with risk. For example, it has been reported that there is a potential threat of environmentally unfriendly materials leaching from the Portland cement binder into the recycled concrete aggregate used in road construction (Apul et al. 2003; Petkovic et al., 2004). Managing risk, however, is likely to require an investment of time and cost.

## **5.0 RESEARCH INTO INNOVATION IN SME DOMESTIC BUILDERS**

The need to meet global issues such as sustainability, all the while remaining competitive, provides the construction industry with challenges that can only be met by the development and use of innovative materials, processes and practices. In order to establish a better understanding of the way in which innovation occurs in SME firms in the residential building construction sector, owners or senior management personnel of 20 smaller building construction firms in South-East Queensland (Australia) participated in a face-to-face interview. This took place in September and October 2006 and dealt with the interviewees' use and adoption of innovative materials and practices.

This form of research was undertaken because of the potential to gain rich data from the representatives of the firms (usually owners or managers) being interviewed. The research design, which utilised a semi-structured interview process, also allowed the interviewer to explain the project to the interviewee and to focus on the innovation process. This would have been more difficult with a mailed questionnaire. The approach also suited the work environment since there were only a limited number of firms available for interview, largely on account of the time constraints currently experienced in the industry.

The firms responded to a request for interview made to 100 businesses randomly selected from publicly available lists of residential property builders. Builders who agreed to take part were visited at their workplace or office and interviewed for an average of 45 minutes. The purpose of the research was to address the extent of innovation in these firms, assess why it occurred, establish the factors aiding or impeding its development, and learn what could be applied from this for the benefit of researchers, practitioners, and the broader industry. An important section of the interview questionnaire sought views of builders with regard to environmentally sustainable design and/or construction practices. This paper concentrates on responses to this section of the questionnaire.

Seven of the firms interviewed had four or fewer staff, 11 had five to 19 staff, and two had just over 19 staff. Of the firms, 18 were primarily constructors, and the other two were primarily engaged in renovation and maintenance. Several firms undertook design as well as construction. All were involved in private sector residential work, with smaller projects (such as private dwellings) predominating. A number of firms also carried out larger projects. Since only 20 per cent of the firms contacted responded to the request for an interview, it could be argued that these were the firms most interested in innovation. To counter this, it should be borne in mind that, at the time of the interviews, the Australian building industry was experiencing a period of high activity. Thus a number of builders with an interest in innovation may have been unable to spare the time for a reasonably lengthy interview (the authors were advised of this by several builders). Low rates of response to research studies are not unusual in the construction industry. For example, a major Australia-wide mailed

questionnaire on innovation in the construction industry recorded a comparable 29 per cent response rate (Manley et al., 2005, p. 20).

## 6.0 RESULTS OF THE RESEARCH

### 6.1 SUSTAINABILITY-RELATED INNOVATION IN THE FIRMS

The firms whose management were interviewed provided 50 examples of innovation, with incremental product and process innovations (using the OECD 2005 classification) predominating. While 16 (i.e., 80 per cent) of the builders interviewed had developed at least one innovation in their firm with minimal or no external input, all except a handful of the innovations could be considered new to the firm rather than new to the construction industry.

From the point of view of sustainability, 14 (i.e., 26%) of the innovations could be classed as primarily meeting a sustainability objective. A further two innovations were assessed as having sustainability as a secondary objective. Of this total of 16 innovations, nine could be considered product innovations, two as process innovations, four as product and process innovations, and one as a product and marketing innovation. Examples of sustainability related innovations were provided by 11 of the 20 participating firms.

The firms were asked to select a particular innovation and asked why they developed or used the particular innovation. To answer this question, firms were asked to either select a response from a short set of example responses, or describe in their own words why they selected the innovation. The responses showed a range of reasons, which varied from an interest in sustainability by the principal of a particular firm, to the specific business objective of improving productivity and/or efficiency.

Seven of the firms nominated an innovation that was either primarily or secondarily related to sustainability as the innovation that would be explored in depth. These seven innovations are shown in Table 1. This table shows the OECD (2005) classification of the selected innovation (i.e., a product, process, organisational or marketing innovation). In addition, it lists the reason why the firm developed or used the particular selected innovation.

Table 1: Selected Sustainable Design and Construction Practices

Innovation	OECD (2005) Classification	Why innovation was developed or used
Design and construction focused on sustainable practices	Process	Better way to develop houses
Improved design to suit sustainable construction and energy efficiency	Product	Client requirement; improve productivity
Retrofitting solar passive principles to older buildings	Process	Personal interest
Comprehensive sustainable housing package	Product	Need to demonstrate leadership in this area
Adoption of new building materials to improve environmental efficiency	Product and process	Committed to sustainable practices
Use of polystyrene blocks as substitutes for other materials as they are insulating and do not emit dust when cut	Product and process	Seemed good practice
Use of new engineered products such as laminated veneered lumber (LVL) beams as substitutes for timber beams	Product and process	Improve productivity and efficiency

The remaining nine sustainability-related innovations nominated by the firms included orientation of buildings to maximise use of the natural environment, insulation using suitable

materials, environmentally aware surface water management, and saving water through the use of plastic downpipes flowing into tanks.

Some of the sustainable design and construction innovations also impacted on project efficiency, in addition to the health and safety of workers, because the materials were lighter than the traditional materials that they replaced. For example, polystyrene blocks are lighter and easier to place than conventional bricks, while laminated veneer lumber products, on account of their relatively light weight vis-à-vis conventional timber, save time with respect to handling and placing. This may be an important consideration when considering how sustainability practices might drive innovation.

## **6.2 WHY FIRMS MIGHT USE SUSTAINABILITY-RELATED INNOVATIONS**

As part of the process of identifying drivers for the use of sustainable practices in Australian construction industry SMEs, the firms in the study were asked to:

- Identify the key issues in sustainable practices in the construction industry;
- Evaluate the main benefits of using such practices;
- Assess any changes to business practices resulting from their use;
- Rate the reasons why they might use them; and
- Rank (if applicable) possible reasons why they might not use them.

Positive key issues with respect to sustainable practices included:

- Key driver for business;
- Good idea;
- Makes firm competitive;
- A point of difference; and
- Water efficiency.

Negative issues included:

- Cost and availability (of suitable materials);
- Firm would only undertake sustainable practices if required;
- Tight margins, which were viewed as a barrier to adopting sustainable practices and;
- Some sustainable practices are being forced on firms.

Builders were also asked to rank a number of perceived benefits from using sustainable practices on a 5-point Likert scale, with 1 for the lowest ranking, and 5 for the highest. These benefits and the average ranking for each (in brackets after the benefit) were as follows:

- Improved reputation in the industry (3.90 – selected by all 20 firms);
- Improved prospects for firms (2.95 – selected by 19 firms);
- Improved productivity (2.35 – selected by 19 firms);
- Improved profit (2.30 – selected by all 20 firms); and
- Less exposure to long-term risk (2.90 – selected by 19 firms).

Other benefits cited by firms included improvement of quality of living spaces, minimising the need for air conditioning and improved energy efficiency.

Negative responses to this question included negative perception of products by clients, increased building costs, and risks such as possible long-term liability for the contractor because of building performance issues related to the increased complexity of sustainable construction. While the relatively small size of the sample of builders means that these

results are not statistically significant, they do give an indication of the views of the members of the sample.

The builders were also asked whether any aspects of the use of sustainable practices required them to make changes to their business practices. Twelve of the 20 builders interviewed responded negatively (one stated that sustainable practices were now part of business), and only eight believed that they would be required to make business changes as a result of using such practices. Reasons for business change included the following:

- Introduced another step in the process;
- Cultural changes;
- Training of trades and contractors;
- Need to do more research and better understand the issues; and
- Practicability.

Finally, the builders were also asked to rate the reasons why they might use these practices, with the following average rankings out of 5:

- You know it is good practice (4.55 – selected by all 20 firms);
- Client imposed (2.80 – selected by all 20 firms); and
- Required by legislation (4.45 – selected by all 20 firms).

Other factors included expectation by particular clients and the need for designers to take the lead.

Only seven of the 20 builders interviewed indicated that they would not use new and/or improved sustainable practices. A low response rate to this question precluded any real assessment of the reasons why these builders would not use such practices. The most cited issues, however, were that these practices were not profitable (related to increased cost), and that they had not been tested. Time was also an issue. Other concerns included a lack of tradespeople with the necessary expertise to implement sustainable practices, being less able to compete in the industry, potential increased liability (arising from, for example, increased project complexity), and the inability of legislation to keep up with innovative sustainable practices (such as the use of grey water).

### **6.3 SUSTAINABILITY RELATED RANKING OF INNOVATION PROCESS FACTORS**

A final step in the research process was to ask the builders to rank 25 factors in the innovation adoption and transfer process on a 1 to 5 Likert scale, again with 1 for lowest ranking and 5 for highest ranking. Two of the questions related to environmental sustainability. Of related interest were three questions focussing on the use of new ideas or products (which gives a view of the firms' attitude to innovation) and receiving either short-term gain or long-term gain from an innovation (which gives an insight into long-term issues as opposed to a short-term focus). All builders in the sample responded to all questions asked. The factors are relevant to environmentally-sustainable practices. Their average rankings out of 5 are as follows:

- Using new ideas or products in your firm (4.40 – quite high);
- Receiving short-term gain from adopting an innovation (2.85 – lowest);
- Receiving long-term gain from adopting an innovation (4.45 – highest);
- Developing or using an innovation that improves environmental sustainability (4.10 – ranked at 4 or above by 16 builders); and
- An industry-wide approach to environmental sustainability (such as a voluntary code of practice) (3.80 – ranked 4 or above by 12 builders)



For this aspect of the research, firms were positive about innovation and its impact on their long-term viability. While they were less positive in their attitudes towards environmental sustainability, it still ranked fairly highly.

## **7.0 DISCUSSION**

Of the 50 examples of innovations provided by the firms interviewed for the research discussed in this paper, 16 (i.e., 32%) were of a sustainability nature. These innovations were developed or adopted by 11 of the 20 firms in the interview sample. In addition, several of the firms evidenced a positive approach about sustainable practices, with some taking a leading role in this area (refer to Table 1). As well, the firms interviewed generally believed that using sustainable approaches was good practice. Finally, there was considerable interest in these firms with respect to receiving long-term gains from innovation as opposed to short-term benefit.

On the other hand, several builders interviewed were unsure about the benefits of introducing sustainable practices. Such concerns included cost, client perception, inability to obtain tradespeople with the necessary expertise, long-term risk arising from complexity of and uncertainty about innovative practices, and sustainable materials. These concerns are similar to barriers to innovation discussed earlier in this paper. Therefore, while the builders interviewed for this research were on the whole in favour of sustainable practices and had a long-term view to innovation, the uncertainty of several of them with respect to such practices indicates that it cannot be concluded that environmental sustainability is at the moment a significant driver for innovation for firms of the type researched in this study.

While caution is required in extrapolating the results of the research beyond the sample of builders interviewed, it would therefore appear that barriers for smaller building firms to the development or adoption of environmental sustainability related innovations include possible negative client perception, perceived costs of using sustainable practices, and the risk involving in using them. As a consequence, if environmental sustainability is to become a significant driver for innovation in construction SMEs, as it increasingly is for other sectors of the construction industry, such concerns should be addressed.

The cost and risk of using sustainable materials and processes is likely to be addressed through research. Builders may gain additional comfort with such practices through the development of an industry-wide approach to environmentally sustainable practices, which has the potential to develop a sense of uniformity in the industry about the use of them. Client concerns, which could be expected, like those of the builders, to relate to cost and risk, might be addressed through an education process. Researchers may have an important role in such education. However, it is expected that such education would be best managed by industry associations, which could communicate in language understood by clients and builders. Firms that are currently taking the lead in using sustainable practices could also play a role in this process, particularly if their success can be demonstrated and communicated to more resistant elements in the industry.

## **8.0 CONCLUSION**

While this research into a sample of small builders has shown that firms in the small to medium residential building sector can be quite innovative, particularly at the practical level, the impact of environmental sustainability on innovative business practices varies from firm to firm. In view of this, it cannot be definitely concluded that it is currently a driver of innovation for this sector.

On the other hand, the research discussed in this paper has demonstrated that, on the whole, firms are becoming increasingly committed to innovation and long-term gains, and maintain a generally positive view regarding sustainable design and construction practices. This outcome demonstrates that, in the residential building construction industry, there are leaders committed to take the sector to higher levels of sustainability. These leaders, working in conjunction with industry associations and researchers, would, it is contended, be in a good position to demonstrate and communicate the success of sustainable practices to clients and fellow builders, and thereby enhance the ability of environmental sustainability in order to drive positive innovation in construction SMEs.

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